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MEMORANDUM

To:	U.S. Environmental Protection Agency, Region 10
From:	Pre-RD AOC Group
Date:	August 28, 2019
Subject:	Portland Harbor PDI; fish tissue-sediment relationship exploration
Project No.:	CF1144-507

A July 31, 2019 email from EPA to the Pre-RD Group listed four initial questions about the Portland Harbor PDI Evaluation Report. This memorandum documents a response to one of those questions: "What does the spatial relationship between the fish tissue and surface sediment concentrations look like; specifically, is there a relationship present between tissue and sediment?" The attached table and figures prepared in response to this question compare fish tissue and sediment concentrations on small (100-foot) scales and on river mile scales.

Small-scale Evaluation

The small-scale evaluation assumes that the fish lives and eats on this small area, which is counter to the fish tracking. Fish and sediment data were paired by averaging all surface sediment measurements within 100 feet of each fish sampling location (Table 1 shows the individual samples used). Pairs were evaluated using linear regression (Table 2). Fish and sediment data were log-transformed as necessary to meet regression requirements for uniform variances. The regression model used accounted for variability in the sediment measurements as well as variability in the fish measurements (a Model II regression).

Regression analysis was performed on data sets which excluded anomalously high data points, and is shown in (Figures 1a, 2a, 3a, 4a, and 5a; Table 2). In addition, regression analysis was performed on the entire data set, which shows a disproportionate effect, or high leverage, based upon a few unusually high concentration points (Figures 1b, 2b, 3b, 4b, and 5b).

PDI Evaluation Report - Appendix H: Evaluation of EPA's Food Web Model

Appendix H examined factors that contribute to the uptake of total PCBs and DDx into SMB tissue through a series of linear regressions on river mile scales using the 2018 PDI dataset. To develop these regressions, individual fish samples were co-located with 1-RM SWACs centered on the location where each fish was collected. Three possible linear tissue-sediment models were calculated for total PCBs and DDx:

- Untransformed tissue concentrations vs. sediment concentrations
- Untransformed tissue concentrations vs. log-transformed sediment concentrations
- Log-transformed tissue concentrations vs. log-transformed sediment.

Figures 5a and 5b from Appendix H of the Evaluation Report are included here as Figures 6a and 6b (of this transmittal).

Conclusions

The small-scale and river mile regressions indicate that there is little-to-no evidence to support a functional relationship between collocated sediment and fish tissue concentrations for the focused COCs. This analysis further supports findings noted in Appendix H of the Evaluation Report with respect to the Food Web Model's reliance upon sediment contaminant concentrations to estimate fish-tissue concentrations. The analysis presented in Appendix H showed that the FWM over-predicts whole body SMB tissue concentrations for total PCBs and DDx. In fact, the FWM calculated a total PCB fish tissue concentration 16.6 times higher than a SMB tissue sample actually collected from Swan Island Lagoon during the PDI. The FWM also failed to corroborate the downward trend in SMB tissue concentrations observed in several independent sampling events conducted since 2002. These analyses indicate there is neither a discernable spatial nor concentration correlation between sediment COCs and SMB tissue results.

Table 1. Fish Tissue Concentrations and Paired Sediment Concentrations (PDI 2018)

Tissue Sample	Sediment Sample	Units	1,2,3,7,8-PeCDD				2,3,4,7,8-PeCDF				2,3,7,8-TCDD				DDx				Total PCB Congeners			
			Tissue Concentration		Sediment Concentration		Tissue Concentration		Sediment Concentration		Tissue Concentration		Sediment Concentration		Tissue Concentration		Sediment Concentration		Tissue Concentration		Sediment Concentration	
PDI-TF-SMB004	PDI-SG-S013	µg/kg	0.000454	J	0.0002	J	0.000601	J	0.00053	J	0.000283		0.000071	J	76.7		1.3		376		231.2	
PDI-TF-SMB007	PDI-SG-S017	µg/kg	0.000588	J	0.00019	J	0.000504	J	0.00025	J	0.000337	J	0.000074	J	59		0.96		238		28.82	
PDI-TF-SMB009	PDI-SG-B042-BL1	µg/kg	0.000544	J	0.00017	U	0.000427	J	0.0012	J	0.000243	J	0.0001	U	65.9		16.93		119		20.98	
PDI-TF-SMB012	PDI-SG-B053-BL1	µg/kg	0.000399	J	0.000061	U	0.000448	J	0.00018	U	0.00021	J	0.000051	U	71.7		0.45		108		1.16	
PDI-TF-SMB016	PDI-SG-S024	µg/kg	0.000503	J	0.00053	J	0.000642	J	0.00048	J	0.000337		0.00024	J	73.5		7.1		1220		41.75	
PDI-TF-SMB017	PDI-SG-S040	µg/kg	0.0006	J	0.00036	J	0.000621	J	0.00049	J	0.000291	J	0.00005	U	65.5		12.94		257		66.03	
PDI-TF-SMB019	PDI-SG-B091-BL1	µg/kg	0.00058	J	0.00022	U	0.000559	J	0.00029	U	0.000318		0.000075	U	78.9		6.57		158		7.85	
PDI-TF-SMB022	PDI-SG-S046	µg/kg	0.000431	J	0.00047	J	0.000612	J	0.0012	J	0.000289	J	0.00041	J	69		11.04		132		10.41	
PDI-TF-SMB023	PDI-SG-S046	µg/kg	0.000361	J	0.00047	J	0.000898	J	0.0012	J	0.000261	J	0.00041	J	80.7		11.04		151		10.41	
PDI-TF-SMB025	PDI-SG-S058	µg/kg	0.000578	J	0.000036	U	0.000918	J	0.000032	U	0.000334		0.000034	U	70.8		0.27		431		8.85	
PDI-TF-SMB026	PDI-SG-S063	µg/kg	0.000764	J	0.0005	J	0.000846	J	0.0009	J	0.000339		0.00044	J	81.8		5.65		228		7.76	
PDI-TF-SMB027	PDI-SG-B126-BL1	µg/kg	0.00044	J	0.00043	U	0.00061	J	0.0015	J	0.000317		0.00048	J	82.8		13.49		136		16.91	
PDI-TF-SMB031	PDI-SG-B151-BL1	µg/kg	0.000613	J	0.00021	U	0.000781	J	0.00032	U	0.000359		0.000089	U	66.6		10.27		306		19.6	
PDI-TF-SMB031	PDI-SG-S079	µg/kg	0.000613	J	0.00084	J	0.000781	J	0.0019	J	0.000359		0.00039	J	66.6		5.81		306		30.93	
PDI-TF-SMB032	PDI-SG-S078	µg/kg	0.000216	J	0.0002	J	0.000511	J	0.00054	J	0.000173	J	0.00019	J	46.3		5.47		77.1		4.82	
PDI-TF-SMB033	PDI-SG-S088	µg/kg	0.000756	J	0.0015	J	0.000728	J	0.0014	J	0.000296		0.00032	J	92.6		10.56		183		28.59	
PDI-TF-SMB033	PDI-SG-S089	µg/kg	0.000756	J	0.00061	J	0.000728	J	0.00067	J	0.000296		0.00014	J	92.6		7.95		183		21.97	
PDI-TF-SMB034	PDI-SG-B165-BL1	µg/kg	0.000345	J	0.001	J	0.000949	J	0.0018	J	0.000283	J	0.00034	J	87.3		6.6		148		6.54	
PDI-TF-SMB035	PDI-SG-S097	µg/kg	0.000308	J	0.00046	J	0.000455	J	0.001	J	0.000308	J	0.00019	J	82.4		6.72		214		17.3	
PDI-TF-SMB038	PDI-SG-S111	µg/kg	0.000383	J	0.00091	J	0.00048	J	0.00081	J	0.000259	J	0.00029	J	84.5		7.77		169		19.61	
PDI-TF-SMB041	PDI-SG-S118	µg/kg	0.000657	J	0.00071	J	0.0023		0.02		0.000353		0.00036	J	208		21.65		243		12.02	
PDI-TF-SMB048	PDI-SG-S144	µg/kg	0.00369		0.01		0.00649		0.0049	J	0.000686		0.0023		54.9		6.22		136		10.85	
PDI-TF-SMB053	PDI-SG-B240-BL1	µg/kg	0.000432	J	0.00027	J	0.000451	J	0.00042	J	0.000382		0.00021	J	83.3		4.57		305		10.11	
PDI-TF-SMB053	PDI-SG-B240-BL1-D	µg/kg	0.000432	J	0.00042	J	0.000451	J	0.00047	J	0.000382		0.00036	J	83.3		5.52		305		12.71	
PDI-TF-SMB054	PDI-SG-S160	µg/kg	0.00169		0.00055	J	0.00151		0.0023	J	0.000518		0.00038	J	64.5		8.17		199		18.69	
PDI-TF-SMB057	PDI-SG-S164	µg/kg	0.000266	J	0.00069	J	0.000455	J	0.00074	J	0.000219	J	0.00037	J	44.6		4.98		171		13.13	
PDI-TF-SMB059	PDI-SG-B262-BL1	µg/kg	0.000505	J	0.0005	J	0.00115	J	0.00049	J	0.000302		0.00034	J	93.3		5.7		1470		15.54	
PDI-TF-SMB059	PDI-SG-B262-BL1-D	µg/kg	0.000505	J	0.0005	J	0.00115	J	0.00044	J	0.000302		0.00026	J	93.3		5.2		1470		15.14	
PDI-TF-SMB061	PDI-SG-S182	µg/kg	0.000499	J	0.0051	U	0.000408	J	0.0034	U	0.000383		0.0029	U	61.4		20.94		283		239.2	
PDI-TF-SMB064	PDI-SG-S206	µg/kg	0.000535	J	0.0012	J	0.000423	J	0.001	J	0.000273	J	0.00043	J	65.6		4.55		265		36.29	
PDI-TF-SMB066	PDI-SG-B299-BL1	µg/kg	0.000657	J	0.0011	J	0.000477	J	0.00099	J	0.00088		0.00096	J	110		11.1		500		43.4	
PDI-TF-SMB067	PDI-SG-B304-BL1	µg/kg	0.000199	J	0.000075	U	0.000328	J	0.00029	J	0.000255	J	0.000058	U	66.1		3.08		333		10.86	
PDI-TF-SMB069	PDI-SG-S226	µg/kg	0.000471	J	0.00032	U	0.000454	J	0.00059	J	0.000401		0.0005	J	64.2		4.7	U	202		15.46	
PDI-TF-SMB070	PDI-SG-B307-BL1	µg/kg	0.000398	J	0.00031	J	0.00037	J	0.00038	J	0.000248	J	0.00016	J	54.5		7.97		543		40.48	
PDI-TF-SMB074	PDI-SG-B319-BL1	µg/kg	0.000312	J	0.00016	J	0.000593	J	0.00038	J	0.000186	J	0.00017	U	38.3		0.94	U	130		11.5	
PDI-TF-SMB077	PDI-SG-B337-BL1	µg/kg	0.00108	J	0.00029	J	0.00102	J	0.0003	J	0.000473		0.00024	U	36.9		1.29		1100		12.07	
PDI-TF-SMB081	PDI-SG-B353-BL1	µg/kg	0.000309	J	0.00026	J	0.000273	J	0.00024	J	0.000271	J	0.00022	J	44		3.35		252		6.8	
PDI-TF-SMB082	PDI-SG-S262	µg/kg	0.000346	J	0.00053	J	0.000334	J	0.00023	J	0.000299	J	0.00042	J	32		3.65		127		11.63	
PDI-TF-SMB084	PDI-SG-B362-BL1	µg/kg	0.000431	J	0.00052	J	0.000499	J	0.00092	J	0.000365		0.0004	J	33.8		6.26		291		147.8	
PDI-TF-SMB085	PDI-SG-B372-BL1	µg/kg	0.000361	J	0.0005	J	0.000419	J	0.00019	U	0.000276	J	0.00017	U	39.9		3.47		186		13.09	
PDI-TF-SMB090	PDI-SG-B405-BL1	µg/kg	0.000258	J	0.00078	J	0.000269	J	0.00097	J	0.000167	J	0.00097		38.8		6.93		2400		423.6	
PDI-TF-SMB091	PDI-SG-B410-BL1	µg/kg	0.00108	J	0.00013	U	0.00137	J	0.00024	J	0.000344		0.00017	U	44.5		1.67		666		79.34	
PDI-TF-SMB092	PDI-SG-B413-BL1	µg/kg	0.000498	J	0.00019	U	0.000443	J	0.00016	U	0.000248	J	0.00036	U	76.8		2.1	UJ	151		4.29	

Notes:
Sediment samples collected within 100 ft of a fish tissue sampling location were averaged and then paired with the tissue data.

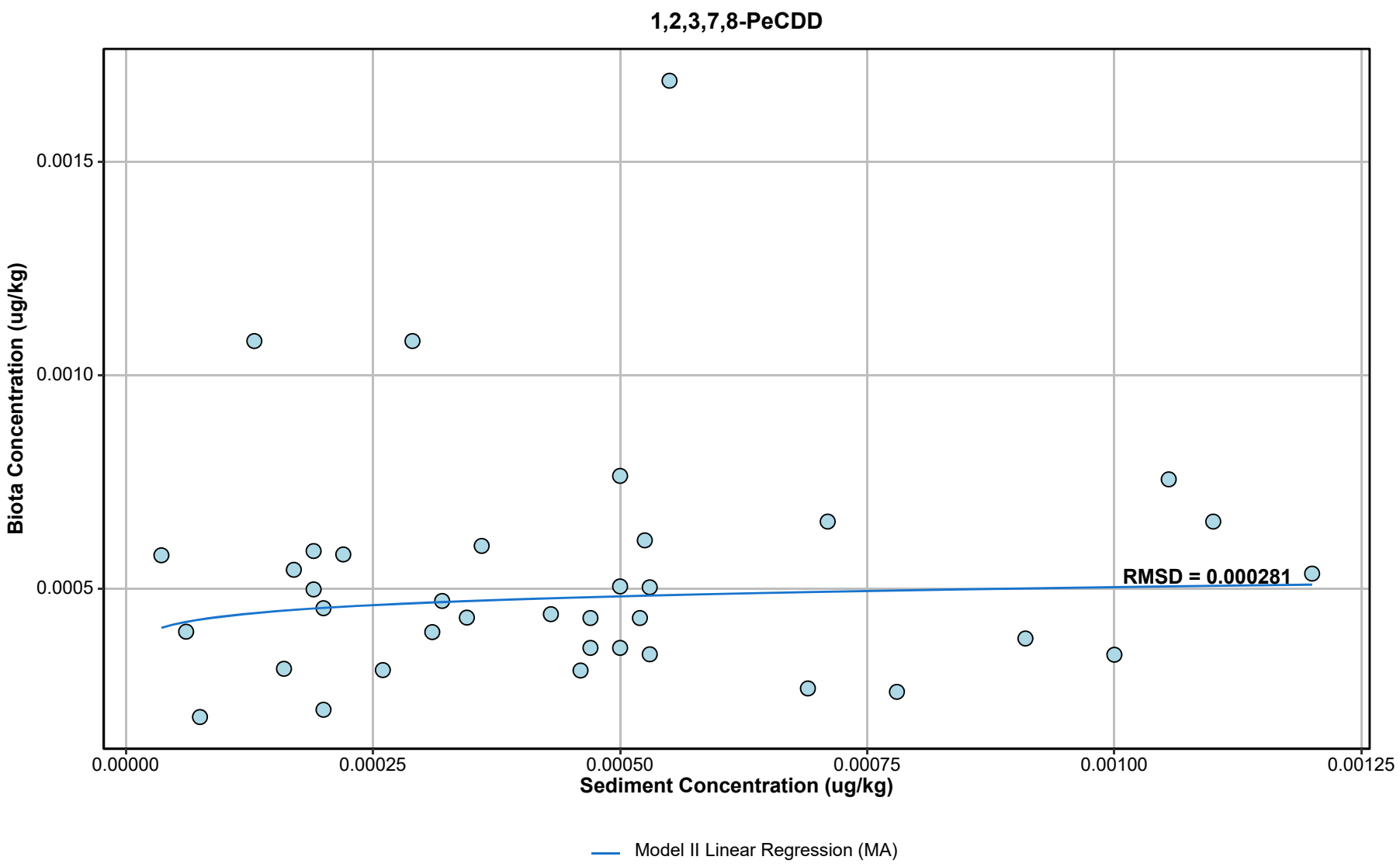
Acronyms:
µg/kg = micrograms per kilogram
DDx = dichlorodiphenyltrichloroethane and its derivatives
J = estimated value
PCB = polychlorinated biphenyl
PeCDD = pentachlorodibenzo-p-dioxin
PeCDF = pentachlorodibenzofuran
PDI = pre-remedial design investigation
TCDD = tetrachlorodibenzo-p-dioxin
U = value below detection limit

Table 2. Model II (Major Axis) Linear Regression Results for Fish Tissue Concentrations versus Paired Sediment Concentrations (PDI 2018)

Analyte	All Data						Censored Dataset					
	n	Sediment Concentration Transformation	Tissue Concentration Transformation	Slope	95% CI for Slope	RMSD (on Tissue Concentration)	n	Sediment Concentration Transformation	Tissue Concentration Transformation	Slope	95% CI for Slope	RMSD (on Tissue Concentration)
1,2,3,7,8-PeCDD	39	natural log	natural log	0.244	(0.041, 0.468)	0.000507	37	natural log	natural log	0.063	(-0.206, 0.342)	0.000281
2,3,4,7,8-PeCDF	39	natural log	natural log	0.312	(0.107, 0.544)	0.000907	37	natural log	natural log	0.054	(-0.151, 0.263)	0.000291
2,3,7,8-TCDD	39	natural log	natural log	0.141	(0.027, 0.259)	0.000118	35	normal	normal	0.178	(-0.044, 0.42)	0.0000679
DDx	39	natural log	natural log	0.141	(0.01, 0.276)	27.4	38	natural log	natural log	0.089	(-0.029, 0.209)	18.3
Total PCB Congeners	39	natural log	natural log	0.476	(0.251, 0.749)	382	38	natural log	natural log	0.385	(0.128, 0.696)	313

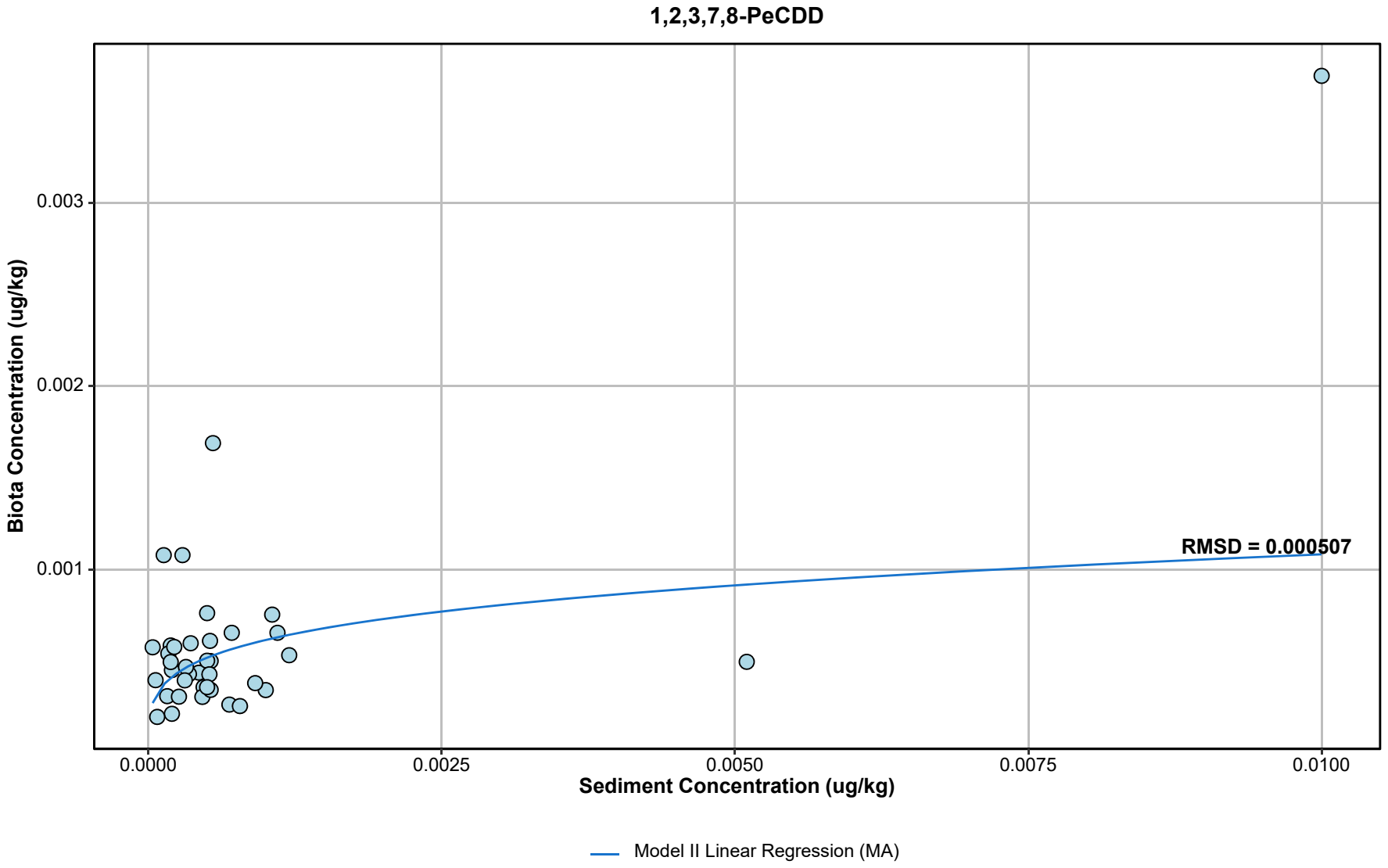
Notes:
Sediment samples collected within 100 ft of a fish tissue sampling location were averaged and then paired with the tissue data.

Acronyms:
CI = confidence interval
DDx = dichlorodiphenyltrichloroethane and its derivatives
n = number of samples
PCB = polychlorinated biphenyl
PeCDD = pentachlorodibenzo-p-dioxin
PeCDF = pentachlorodibenzofuran
PDI = pre-remedial design investigation
RMSD = root-mean-square deviation
TCDD = tetrachlorodibenzo-p-dioxin



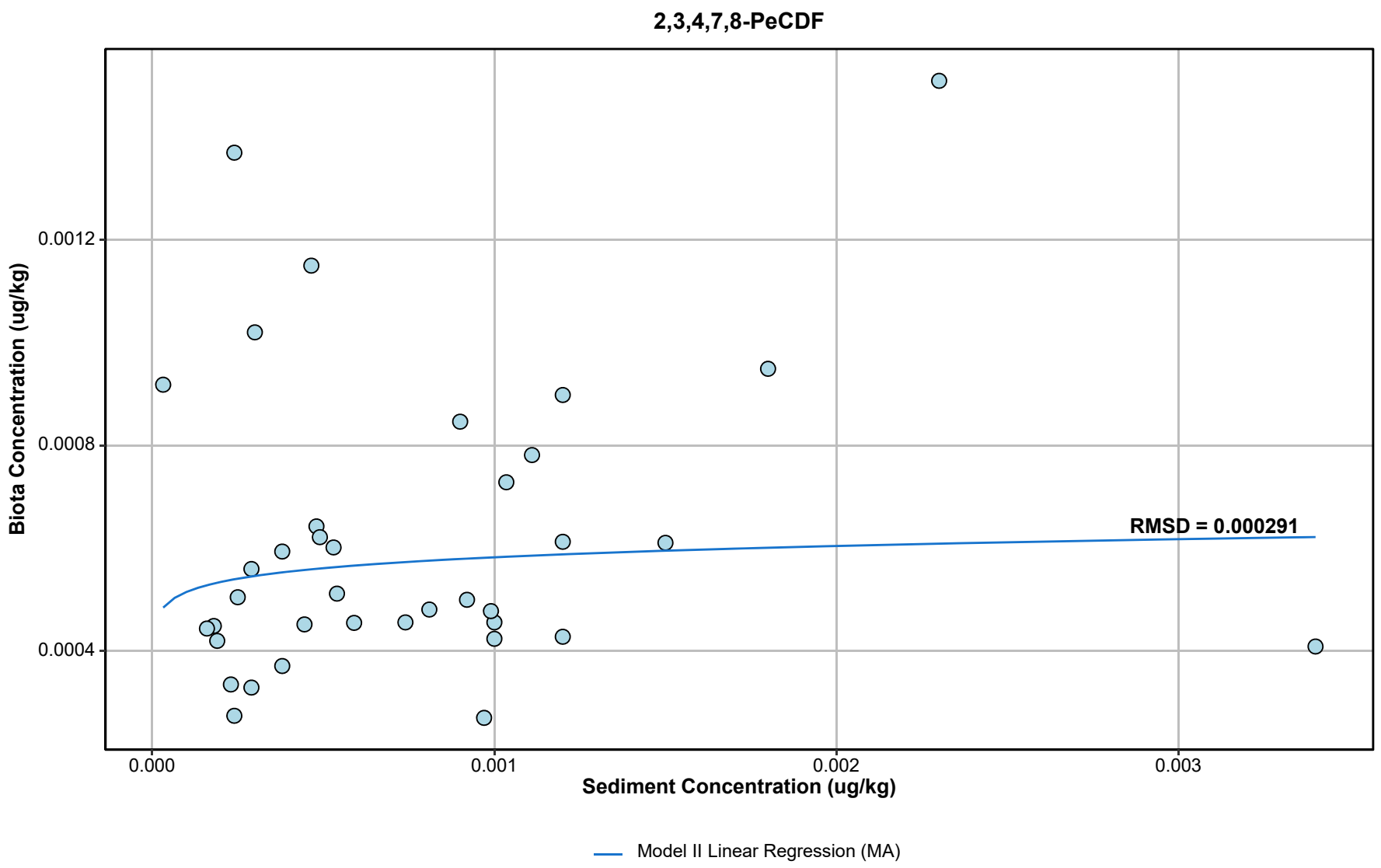
MA – major axis
RMSD – root mean square deviation
Sediment data within 100f ft of a fish tissue sample location were averaged and then paired with the tissue data.

Figure 1a.
Relationship between 1,2,3,7,8-PeCDD Concentrations in Sediment and Fish Tissue Samples
(Censored 2018 PDI Data)



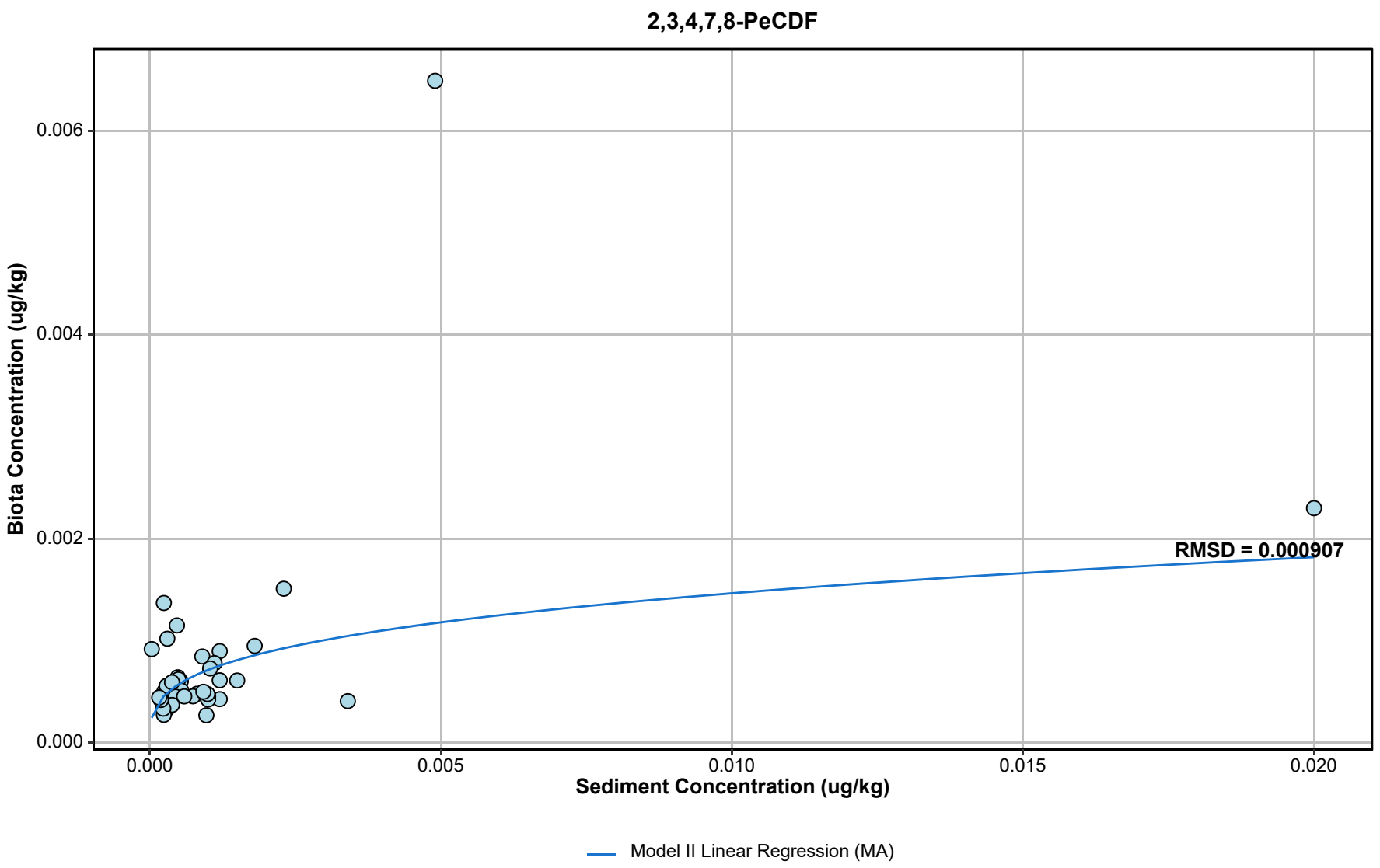
MA – major axis
RMSD – root mean square deviation
Sediment data within 100f ft of a fish tissue sample location were averaged and then paired with the tissue data.

Figure 1b.
Relationship between 1,2,3,7,8-PeCDD Concentrations in Sediment and Fish Tissue Samples
(All 2018 PDI Data)



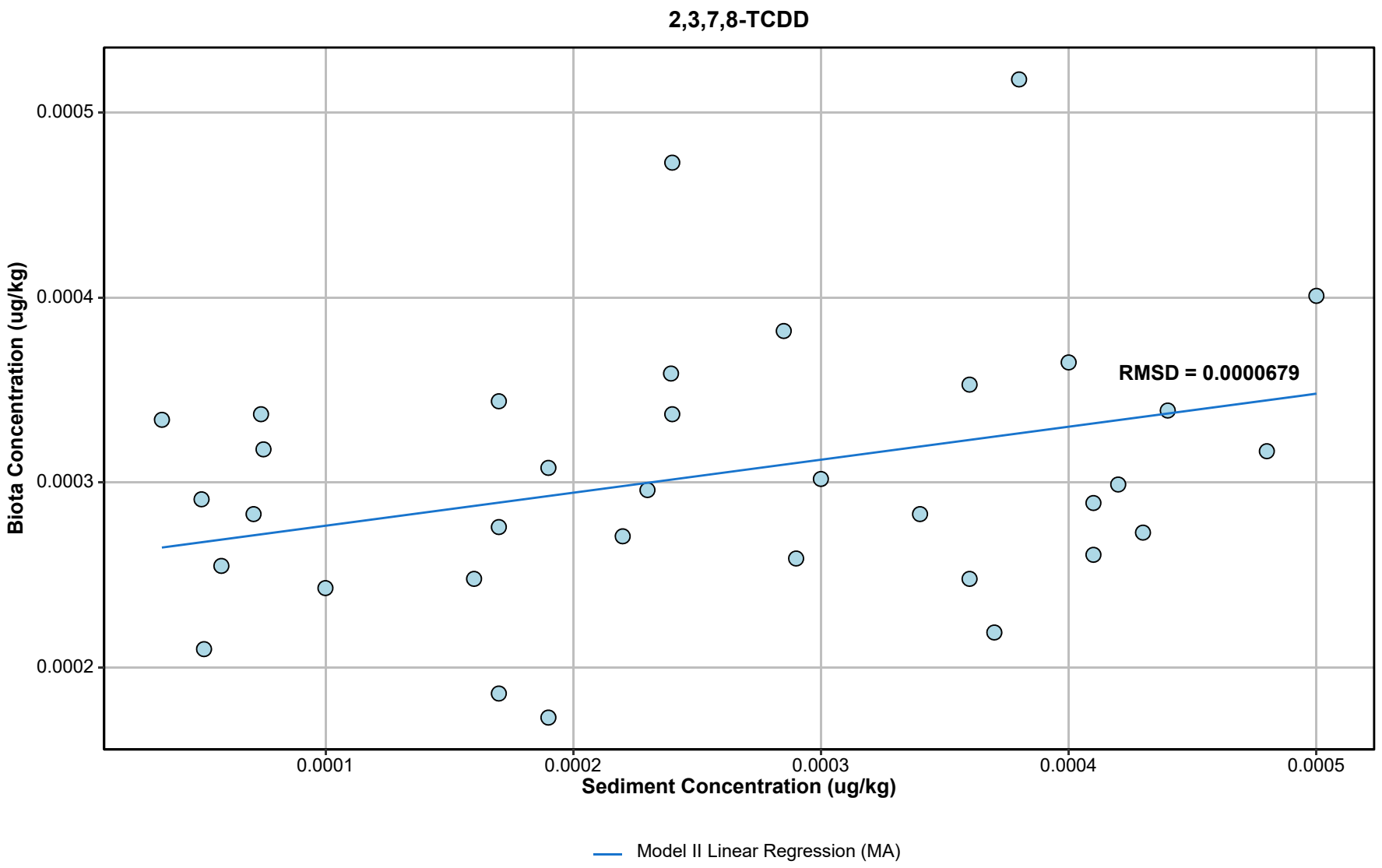
MA – major axis
RMSD – root mean square deviation
Sediment data within 100f ft of a fish tissue sample location were averaged and then paired with the tissue data.

Figure 2a.
Relationship between 2,3,4,7,8-PeCDF Concentrations in Sediment and Fish Tissue Samples
(Censored 2018 PDI Data)



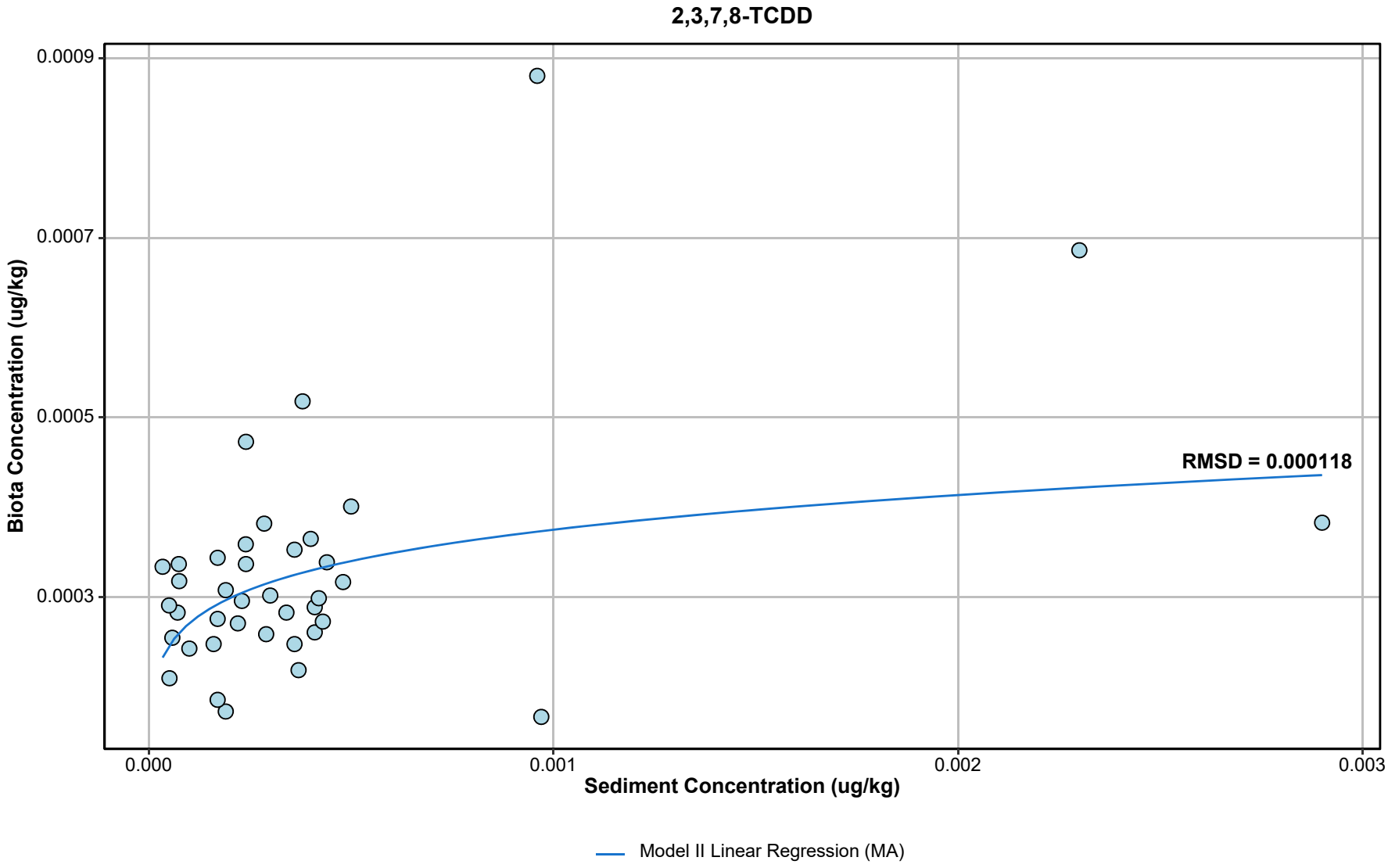
MA – major axis
RMSD – root mean square deviation
Sediment data within 100f ft of a fish tissue sample location were averaged and then paired with the tissue data.

Figure 2b.
Relationship between 2,3,4,7,8-PeCDF Concentrations in Sediment and Fish Tissue Samples
(All 2018 PDI Data)



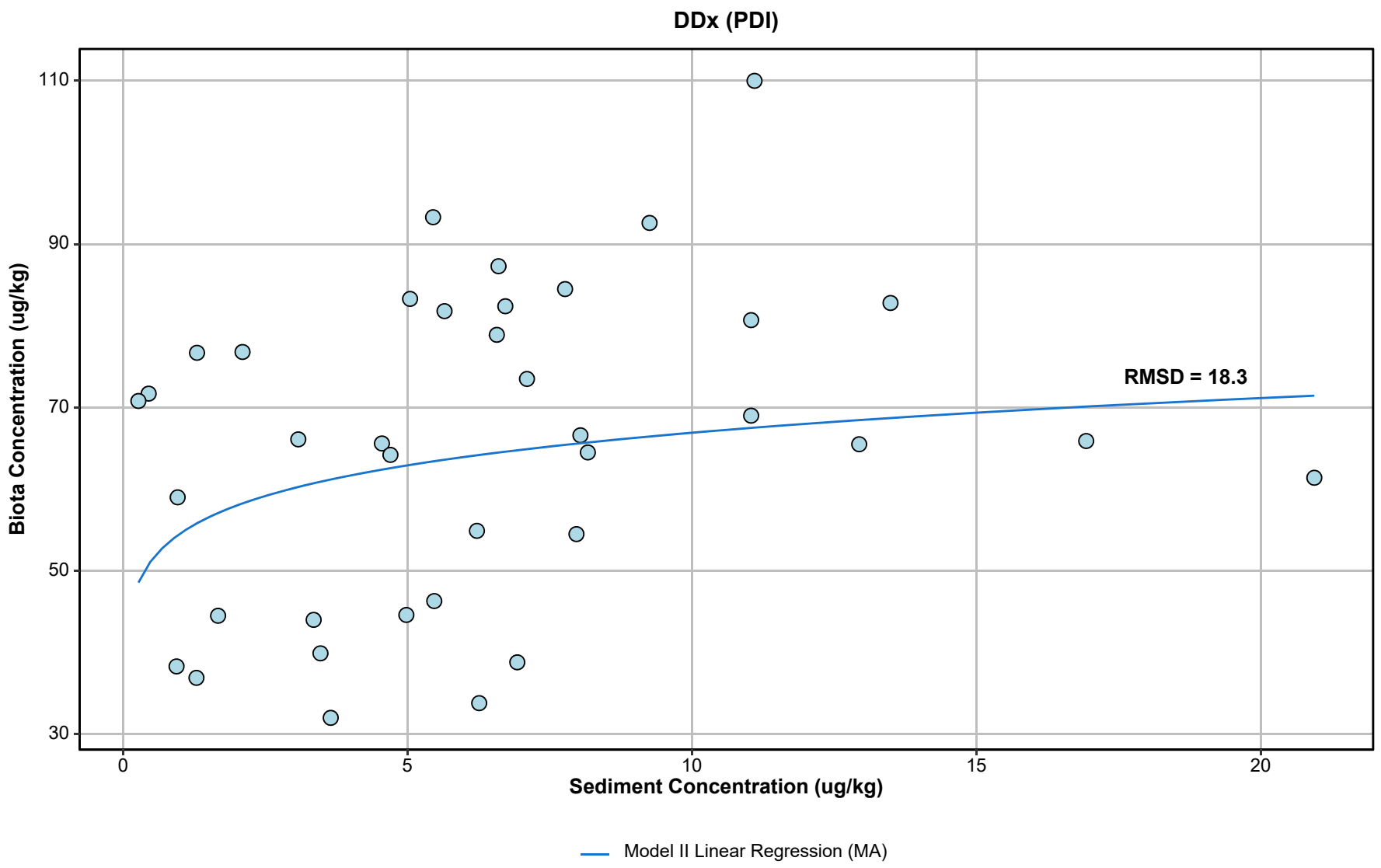
MA – major axis
RMSD – root mean square deviation
Sediment data within 100f ft of a fish tissue sample location were averaged and then paired with the tissue data.

Figure 3a.
Relationship between 2,3,7,8-TCDD Concentrations in Sediment and Fish Tissue Samples
(Censored 2018 PDI Data)



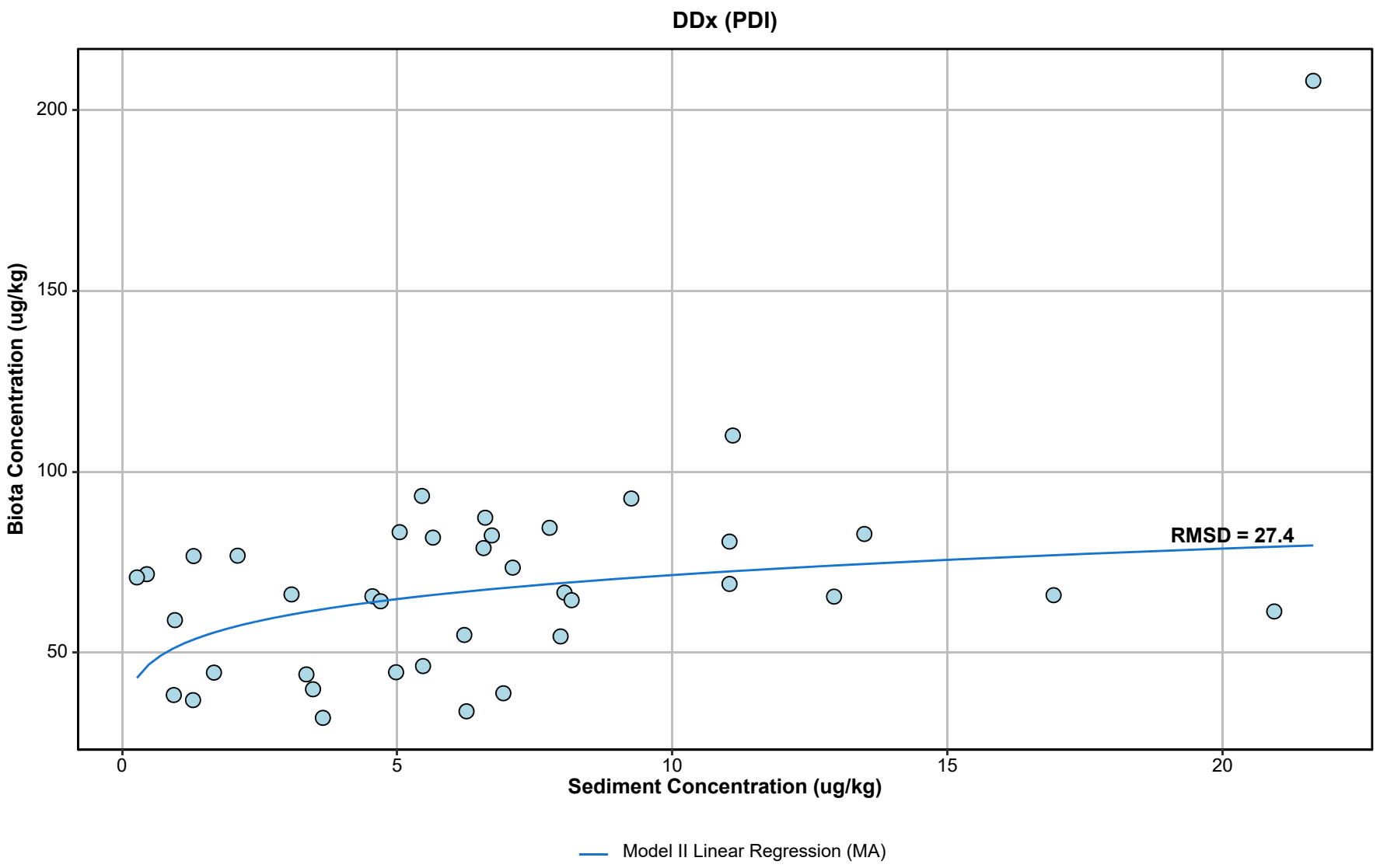
MA – major axis
RMSD – root mean square deviation
Fish tissue data were paired with sediment data within 100 ft

Figure 3b.
Relationship between 2,3,7,8-TCDD Concentrations in Sediment and Fish Tissue Samples
(All 2018 PDI Data)



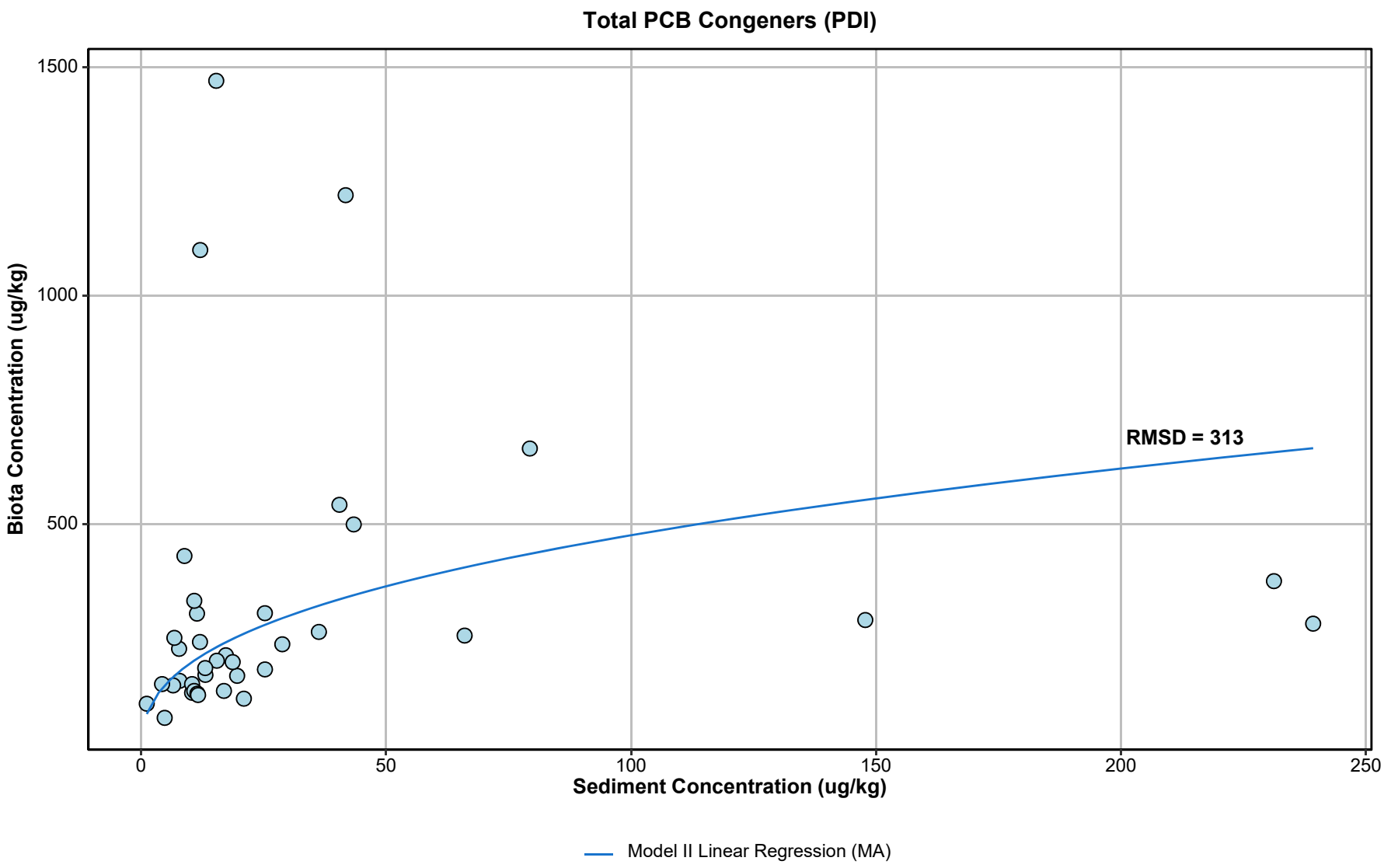
MA – major axis
RMSD – root mean square deviation
Sediment data within 100f ft of a fish tissue sample location were averaged and then paired with the tissue data.

Figure 4a.
Relationship between DDx Concentrations in Sediment and Fish Tissue Samples
(Censored 2018 PDI Data)



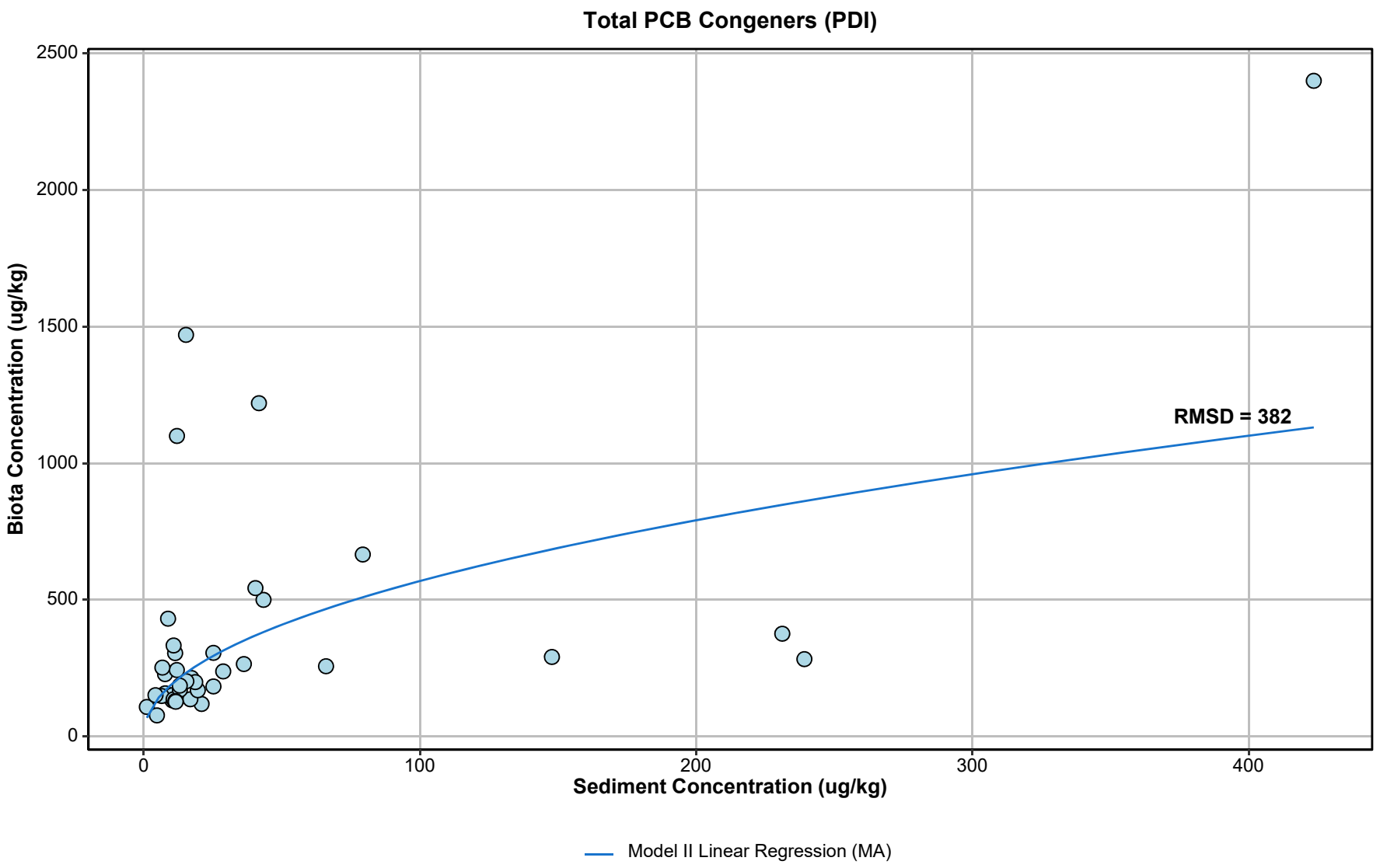
MA – major axis
RMSD – root mean square deviation
Sediment data within 100f ft of a fish tissue sample location were averaged and then paired with the tissue data.

Figure 4b.
Relationship between DDx Concentrations in Sediment and Fish Tissue Samples
(All 2018 PDI Data)



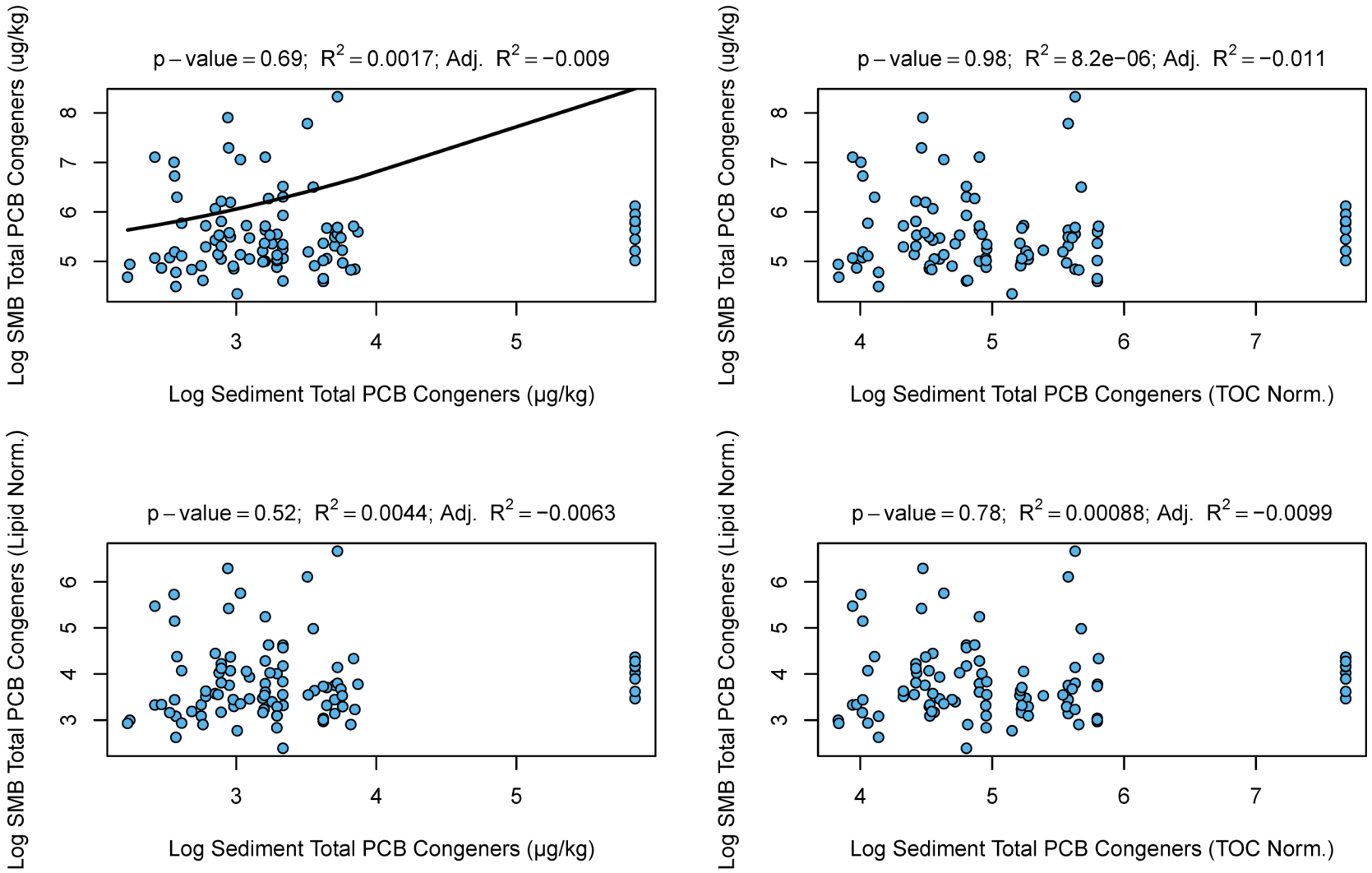
MA – major axis
RMSD – root mean square deviation
Sediment data within 100f ft of a fish tissue sample location were averaged and then paired with the tissue data.

Figure 5a.
Relationship between Total PCB Congeners Concentrations in Sediment and Fish Tissue Samples (Censored 2018 PDI Data)



MA – major axis
RMSD – root mean square deviation
Sediment data within 100f ft of a fish tissue sample location were averaged and then paired with the tissue data.

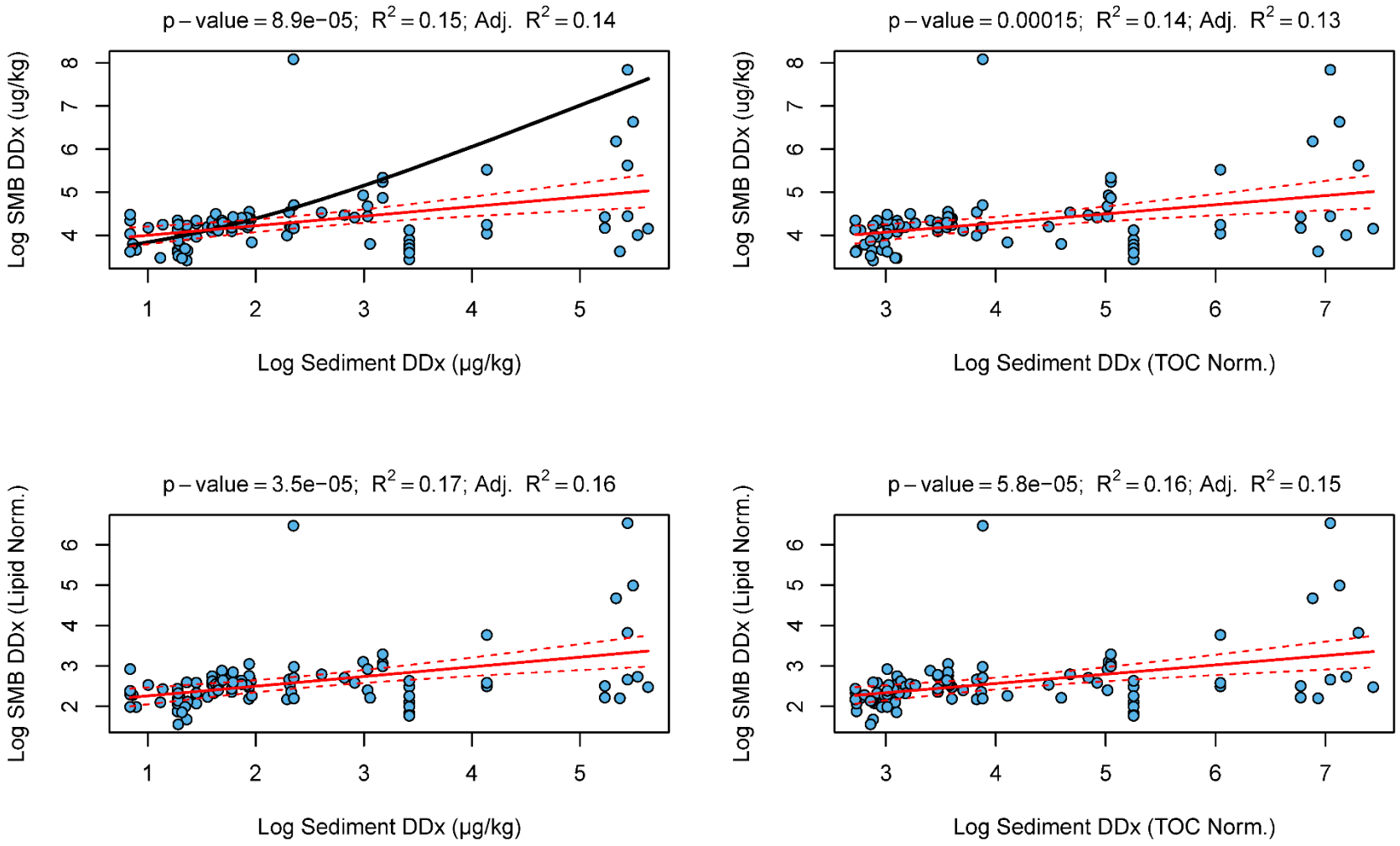
Figure 5b.
Relationship between Total PCB Congeners Concentrations in Sediment and Fish Tissue Samples (All 2018 PDI Data)



Notes:
Regressions used combined SRS+SMA data set
No statistically significant regressions ($p<0.05$) were identified for total PCBs
Black line indicates model results
Sediment concentrations are 1-River Mile SWACs

SMB = smallmouth bass
SWAC = spatially weighted average concentration
SRS = stratified random samples
SMA = sediment management area samples
PCB = polychlorinated biphenyl
TOC = total organic carbon

Figure 6a.
Relationship Between Total PCBs in Sediment and Smallmouth Bass (Whole Body)



Notes:
Regressions used combined SRS+SMA data set
Statistically significant regressions (p<0.05) shown by solid red lines; dashed lines indicate 95% confidence interval
Black line indicates model results
Sediment concentrations are 1-River Mile SWACs

SMB = smallmouth bass
SRS = stratified random samples
SMA = sediment management area samples
SWAC = spatially weighted average concentration
DDx = dichlorodiphenyltrichloroethane
TOC = total organic carbon

Figure 6b.
Relationship Between DDx in Sediment and Smallmouth Bass (Whole Body)